

REDESCRIPTION OF TWO TRICHURID NEMATODE PARASITES OF VERTEBRATES IN AUSTRALIA AND PAPUA NEW GUINEA

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Summary

SPRATT, D. M. (1985) Redescription of two trichurid nematode parasites of vertebrates in Australia and Papua New Guinea. *Trans. R. Soc. S. Aust.* **109**(4), 143-150, 29 November, 1985.

Anderson & Bain, 1982 placed *Paratrichosoma* Ashford & Muller, 1978 as a synonym of *Capillaria* (*sensu lato*) Zeder, 1800. The reasons for this synonymy are discussed herein and *Capillaria crocodilus* (Ashford & Muller, 1978) comb. nov. from tunnels in the epidermis of *Crocodylus novaeguineae novaeguineae* Schmidt in Papua New Guinea is redescribed from co-type specimens.

Trichosomoides nasalis Biocca & Aurizi, 1961 is described and illustrated from the nasal cavity of *Rattus fuscipes* (Waterhouse) in southeastern New South Wales. This represents the first record of the parasite in Australia and *R. fuscipes* is the only murid host known to date.

KEY WORDS: *Paratrichosoma*, *Capillaria*, *Trichosomoides*, Nematoda, distribution, hosts, morphology, Muridae.

Introduction

The Trichuridae is a cosmopolitan family of parasitic nematodes which are poorly understood, both morphologically and biologically. During study of the trichurids of Australasian vertebrates the need arose to re-examine two unusual species, one described originally as *Paratrichosoma crocodilus* Ashford & Muller, 1978 from *Crocodylus novaeguineae novaeguineae* Schmidt at Moitaka crocodile farm, Port Moresby, and *Trichosomoides nasalis* Biocca & Aurizi, 1961 first reported from *Rattus norvegicus* (Berkenhout) in Rome (Aurizi, 1958) and not known to occur in Australia. Redescription of these species and consideration of their taxonomic placement form the basis of this report.

Materials and Methods

Nematodes were fixed in hot, 10% neutral buffered formalin and cleared in lactophenol.

Co-types of *T. nasalis* were kindly loaned to me by Professor E. Biocca of the Istituto di Parassitologia dell' Università di Roma. Loan of male and female paratypes of *Paratrichosoma crocodilus* was kindly arranged by Mrs E. A. Harris of the British Museum.

Measurements were made with the aid of an ocular micrometer, drawing tube, and measuring wheel, and are presented in micrometers unless otherwise stated. Where possible, the range of measurements is followed by the mean, in parentheses. Illustrations were made with the aid of a drawing tube.

Type specimens have been returned to their respective institutions. Representative specimens of

T. nasalis from *R. fuscipes* in Australia have been deposited in the British Museum (Natural History) (B.M.(NH) No. 1981/3537-3540), the Istituto di Parassitologia dell' Università di Roma, the Muséum national d'Histoire naturelle, Paris (MN 476 HB), the South Australian Museum (V3244), the Australian Helminthological Collection (13855), the United States National Museum Helminthological Collection No. 77454 and the helminth collection of the Division of Wildlife and Rangelands Research, CSIRO (N498, 717, 882).

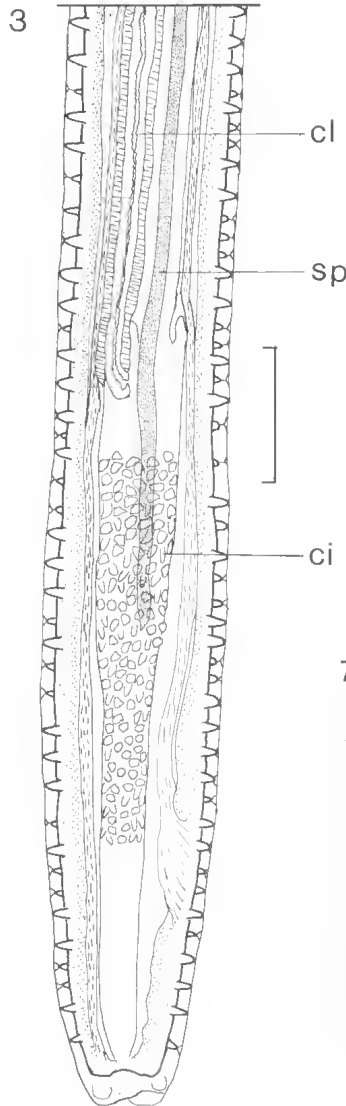
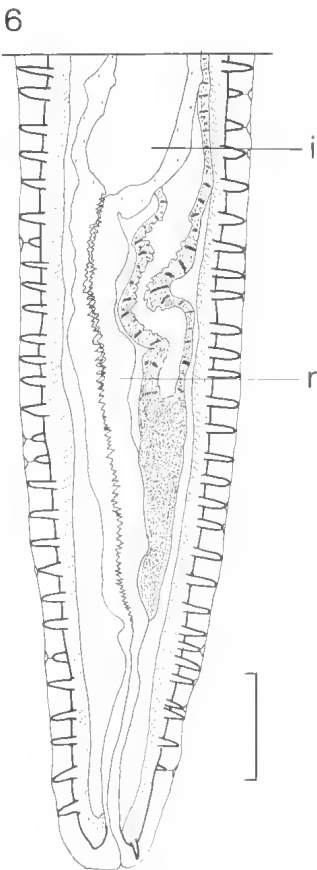
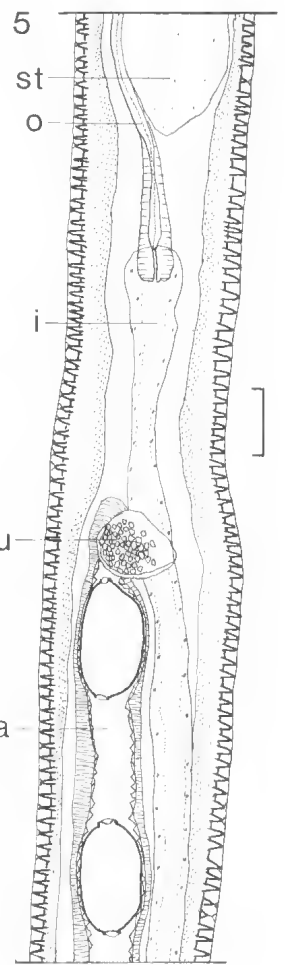
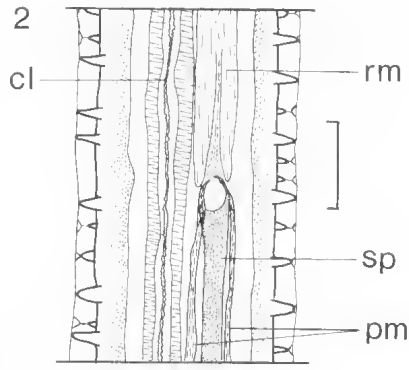
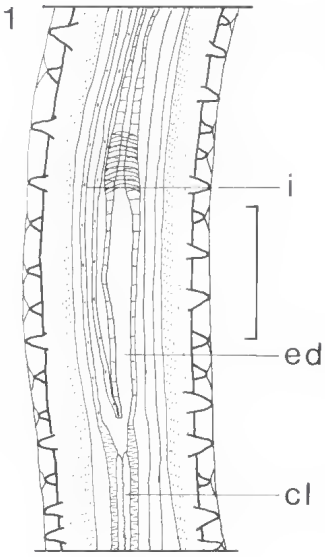
Capillaria crocodilus (Ashford & Muller, 1978)
comb. nov.
FIGS 1-7

Material examined: from *Crocodylus novaeguineae novaeguineae* Moitaka crocodile farm, Port Moresby, 1♂, 1♀ paratypes, BM(NH) coll. No. 1978/917-920.

Redescription

Long thin nematodes with attenuated anterior and blunt posterior extremities. Cuticle exceptionally thick, cuticular striae not observed. Two exceptionally broad lateral and one narrow ventral bacillary bands. Hypodermal gland cells of bands papilla-like in appearance due to necessity for neck of cell to traverse thick cuticle to external pore opening. Lateral alae absent. Cephalic extremity minute, with minute dome possibly consisting of two lips; stylet and buccal capsule not observed. Oesophagus commencing as narrow muscular tube, broadening posterior to nerve ring, narrowing before reaching stichosome, passing through stichosome on dorsal or lateral surface but exiting from it on ventral surface as narrow muscular duct. Stichosome not extending as far as intestine. Narrow muscular oesophagus forming unusual opaque junction with intestine, consisting of two rather than three tissue segments and not

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appearing as true valve. Two mesenchymal cells not present at oesophago-intestinal junction. Stichosome composed of approximately 36 stichocytes, much longer than wide, large nucleus not observed in each stichocyte. Intestine large and conspicuous. Tail broad and blunt, without papillae in female and without alae in male. Anus and cloaca terminal in female and male respectively. Male with short ejaculatory duct, long cloaca lined with cuticle, long robust non-sclerotised spicule, and spicule sheath (=cirrus *sensu* Anderson & Bain, 1982) with robust blunt spines or scales. Female with vulva slightly posterior to oesophago-intestinal junction, vagina vera lined with cuticular spines or scales. Eggs moderately thick-shelled, untanned, shell without ornamentation, eggs in distal uterus not embryonated.

Male

Length 22.7 mm. Width at nerve ring 10, at oesophago-intestinal junction 57; maximum width 66. Length of muscular oesophagus 300; total length of oesophagus 13.6 mm. Length of stichosome 13.2 mm; stichocytes 33 in number; length of stichocytes 260–330. Nerve ring 50 from cephalic extremity. Total length of cloaca 930; length of spiny spicule sheath 150; length of ejaculatory duct 100; spicule pouch entering cloaca 213 from caudal extremity. Spicule present, not sclerotised, 450 in length, 8 in maximum width, capitulum with characteristic "bubble" shape, spicule broad proximally, with broad but tapering point distally. Junction of intestine and ejaculatory duct simple, both ducts same width at junction. Spicule sheath with robust but generally blunt spines or scale-like ornamentation (not everted in this specimen). Spicule retractor muscle inserting 150 anterior to sphincter muscle delineating modification of distal vas deferens into ejaculatory duct.

Lateral and ventral bacillary bands commencing in region of nerve ring; lateral bands 2–3 cells wide, cells regular in distribution; ventral band one cell wide, cells irregular in distribution. Lateral bands broadening rapidly, 10–13 cells in width approximately 5 mm posterior to cephalic end and practically encircling worm; bands narrowing abruptly near tail tip, 7 cells in width at level of entry of spicule pouch to cloaca. Ventral bacillary

band with single column of cells spaced irregularly along body length.

Female

Length 67.5 mm. Width at nerve ring 70, at vulva 113; maximum width 135. Length of muscular oesophagus 270; total length of oesophagus 19.2 mm. Length of stichosome 18.7 mm; stichocytes 37 in number; length of stichocytes 300–580. Nerve ring 60 from cephalic extremity. Vulva 20.2 mm from anterior extremity. Vagina vera 109 long, lined with thick cuticular scales similar in morphology to those on male cirrus. Rectum 201 long, lined with thick cuticle. Anus terminal.

Lateral and ventral bacillary bands commencing in region of nerve ring. Lateral bands 4–6 cells wide, cells regular in disposition; ventral band one cell wide, cells irregular in disposition. Lateral bands broadening rapidly, 10–13 cells in width approximately 5 mm posterior to cephalic extremity, practically encircling worm; bands narrowing abruptly approximately 0.5 mm from tail tip. Ventral bacillary band with single column of cells spaced irregularly along body length.

Discussion

My observations differ markedly from those of Ashford & Muller (1978). This trichurid nematode species from epidermal tunnels in the abdominal skin of crocodiles possesses (i) conspicuous bacillary bands comprised of papilla-like hypodermal gland cells due to the neck of the gland cell having to traverse the thick body cuticle to the external pore opening, (ii) a stichosome comprised of 32–37 elongate stichocytes arranged in a single column, (iii) a long broad non-sclerotised spicule, (iv) a spicule sheath with robust blunt spines and scale-like ornamentation, (v) a long muscular cloaca with thick cuticular lining and (vi) unembryonated eggs in the distal uterus of the female, none of which were reported by Ashford & Muller (1978). The caption to their Fig. 5 contradicts their statement on p. 216, "Eggs unembryonated when laid" and should read, "Egg from skin, containing a larva".

The above-mentioned features are characteristic of the trichurid nematode subfamily Capillariinae

Figs 1–7, *Capillaria crocodilus* (Ashford & Muller, 1978) comb. nov. 1. Male posterior end showing junction of intestine and ejaculatory duct with distal cloaca. 2. Male posterior end showing capitulum of spicule, spicule retractor and protractor muscles, and cloaca. 3. Male caudal end showing cloaca, spiny spicule sheath and distal end of spicule. 4. Blunt spines and scale-like ornamentation on spicule sheath of male. 5. Female anterior end showing oesophago-intestinal junction, vulva and vagina with scale-like ornamentation, ventral view. 6. Female caudal end, ventral view. 7. Lateral bacillary band of female showing neck of gland cells traversing thick cuticle to exterior pore openings. Scale lines: Figs 4, 7, 10 μ m; Fig. 2, 20 μ m; Figs 1, 3, 5, 50 μ m. Abbreviations: cj—spicule sheath (=cirrus *sensu* Anderson & Bain, 1982), cl—cloaca, ed—ejaculatory duct, i—intestine, o—oesophagus, pm—protractor muscle of spicule, r—rectum, rm—retractor muscle of spicule, sp—spicule, st—stichocyte, va—vagina, vu—vulva.

(*sensu* Anderson & Bain, 1982) and differ from the Trichosomoidinae to which Ashford & Muller allocated their genus. In contrast, members of the Trichosomoidinae possess a primitive oesophagus with 60 to 150 stichocytes sometimes arranged in two or three columns, males have a short cloaca but lack both a spicule and a spicule sheath, and eggs are embryonated when laid by female worms. Anderson & Bain, 1982 placed *Paratrichosoma* Ashford & Muller, 1978 as a synonym of *Capillaria* (*sensu lato*) Zeder, 1800. The reasons for this synonymy are presented above and the crocodile parasite is formally recognised as *Capillaria crocodilus* (Ashford & Muller, 1978) comb. nov.

Despite the foregoing, *C. crocodilus* possesses several features which distinguish it from many other members and which may warrant consideration in any future comprehensive revision of the genus *Capillaria*. These are as follows: (i) exceptionally thick cuticle, (ii) exceptionally broad lateral bacillary bands, (iii) anterior muscular oesophagus with median swelling similar to that occurring in first-stage larvae of the Metastrongyloidea, (iv) exceptionally long stichocytes, (v) stichosome terminating well anterior to oesophago-intestinal junction (vi) form of oesophago-intestinal junction, (vii) absence of two mesenchymal cells at oesophago-intestinal junction, (viii) absence of alae or papillae on male and female caudal extremities, (ix) vagina vera lined with cuticular scales similar to those on spicule sheath of male and (x) insertion of spicule retractor muscle well anterior to (rather than at level of) sphincter muscle delineating modification of distal vas deferens into ejaculatory duct.

Ashford & Muller (1978) reported that two crocodiles, *C. novaeguineae novaeguineae* and *C. porosus* Schneider were susceptible to infection with *Capillaria crocodilus*, that the parasite was rare or absent in crocodiles from areas of saline water and that transmission of the parasite does not occur under some rearing conditions on crocodile farms. Undulating nematode worm trails, probably attributable to *C. crocodilus*, have been reported from *C. acutus* Cuvier (Garrick in Webb & Manolis, 1983), *C. intermedius* Graves (King & Brazaitis, 1971), *C. johnstoni* (King & Brazaitis, 1971; Webb & Manolis, 1983) *C. moreletii* Duméril, Bibron and

Duméril (King & Brazaitis, 1971), *C. niloticus* Laurenti (King & Brazaitis, 1971) and *C. porosus* (King & Brazaitis, 1971; Webb & Messel, 1977).

In the Northern Territory of Australia worm trails are more common in larger specimens of both *C. johnstoni* and *C. porosus* (Webb & Messel, 1977; Webb & Manolis, 1983). In Queensland, worm trails occur in *C. johnstoni* 3 years of age and older, and there is an increasing prevalence and density of trails with age. (K. R. McDonald, pers. comm.).

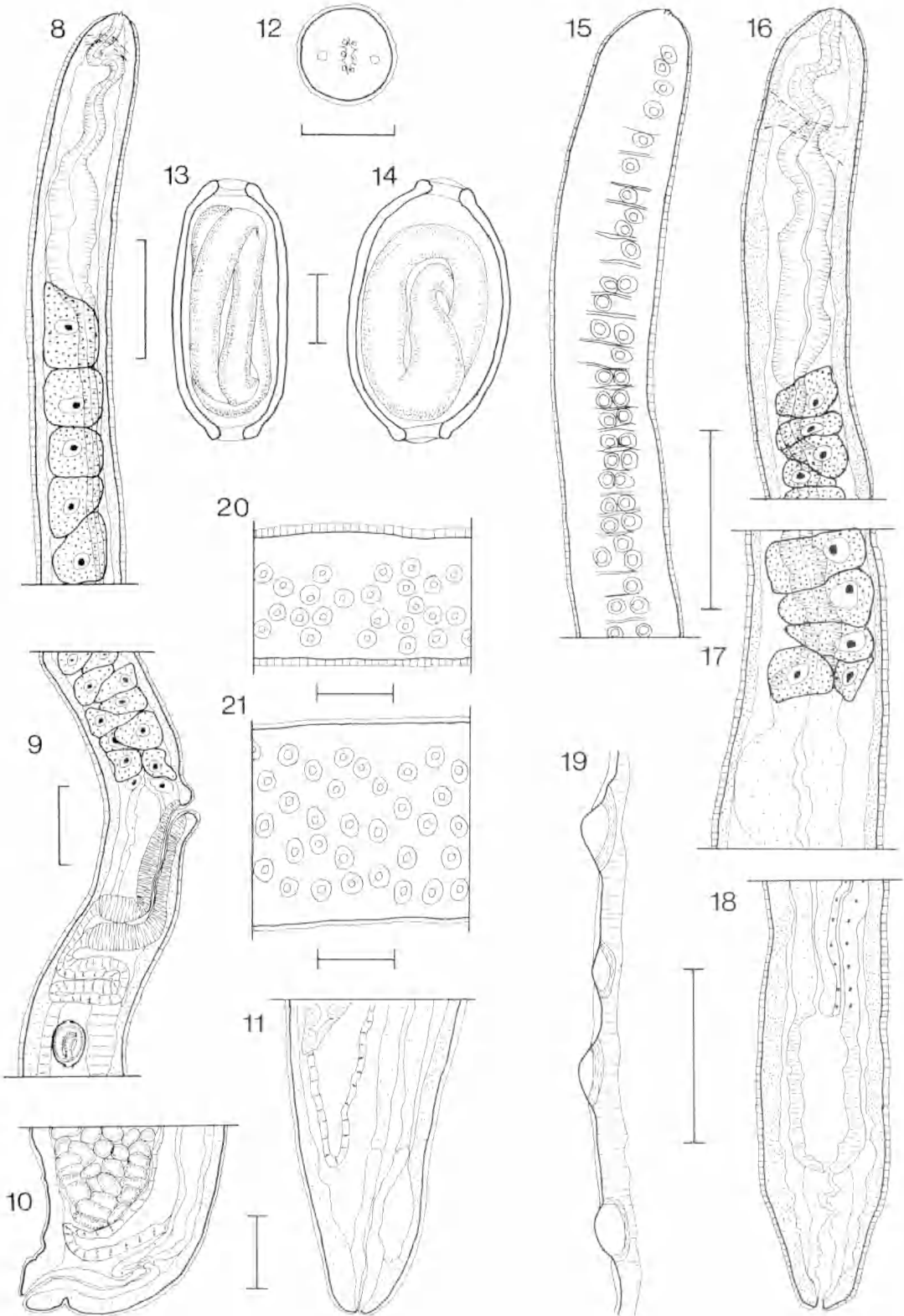
Other species of *Capillaria* (*sensu lato*) (Capillariinae) occur in the skin both of cold-blooded and of warm-blooded vertebrate hosts (Gallego & Mas-Coma, 1975; Moravec & Cosgrove, 1982; Wade, 1982). In addition, Lyne & Sommerville (1965) reported a species of *Capillaria* in skin sections of the lip and scrotum of the marsupial bandicoot, *Perameles nasuta* Geoffroy in Australia. I have recovered adults of species of *Capillaria* from these sites in *P. nasuta* and *Perameles gunnii* Gray, and from epithelial tunnels in the tongue of *P. gunnii*, *P. nasuta* and the small dasyurid marsupials *Antechinus stuartii* Macleay and *A. swainsonii* (Waterhouse). The genera *Anatrichosoma* and *Trichosomoides* (Trichosomoidinae) also contain species which occur in tunnels or burrows in the epithelial tissues of their mammalian hosts (see Discussion in Spratt, 1982 and this paper).

Trichosomoides nasalis Biocca & Aurizi, 1961
FIGS 8–21

Specimens of *Trichosomoides nasalis* were found in the mucosa of the distal nasal cavity of 5 of 232 *Rattus fuscipes* examined from forested coastal and montane habitats (sea level to 1220 metres) in southeastern New South Wales. The parasite was not found in 77 *R. lutreolus* (Gray), 13 *R. rattus* L., 97 *Mus musculus* L. and 8 *Mastacomys fuscus* Thomas examined from these same regions. Numbers of female nematodes recovered from individual rats were 4–34 (\bar{x} =12), those of males living in the uteri of females 2–8 (\bar{x} =5).

Material examined: from *Rattus* (= *Epimys*) *norvegicus*, Rome, Italy, T. Crapulli, co-type ♀ containing 2 co-type ♂♂ *in utero*, fragments 2 co-type ♀♀, 1958, in Istituto di Parasitologia dell' Università di Roma.

Figs 8–21. *Trichosomoides nasalis* Biocca & Aurizi, 1961 from *Rattus fuscipes*. 8. Anterior end, female, dorsal view. 9. Oesophago-intestinal junction and vulva of female, lateral view. 10. Caudal end of gravid female, lateral view. 11. Caudal end of non-gravid female, lateral view. 12. Cephalic end female, *en face* view. 13. Egg from distal vagina of gravid female. 14. Egg adjacent to that in Fig. 13, opposite profile. 15. Anterior end male, lateral view of cuticular ornamentation—pore openings of hypodermal gland cells interrupted by partial but conspicuous transverse striae. 16. Anterior end male, lateral view. 17. Oesophago-intestinal junction, male, lateral view. 18. Caudal end male, lateral view. 19. Elevated hypodermal gland cells of bacillary band in posterior half of female, lateral view. 20. Lateral bacillary band, mid-body region of female. 21. Lateral bacillary band 0.5 mm from caudal end of female. Scale lines: Fig. 12, 10 μ m; Figs 13, 14, 20 μ m; Figs 8, 10, 11, 13, 21, 50 μ m; Fig. 9, 100 μ m.



From *R. fuscipes*, Lee's Creek, A.C.T., P. Haycock and D. M. Spratt, 15♀, 66♂♂, 22.i.1979; Bundarra Creek, Snowy Plains, N.S.W., D. M. Spratt, 34♀, 91♂♂, 22.ii.1978; Emu Creek, Bondo State Forest, near Bondo N.S.W., P. Haycock and D. M. Spratt, 6♀, 21♂♂, 24.xi.1978; Nadgee State Forest, near Eden N.S.W., P. Haycock and D. M. Spratt, 7♀, 23♂♂, 12.xii.1978; E. Walter and P. Haycock, 5♀, 28♂♂, 1.xii.1982.

Redescription

Female relatively long and narrow, with slightly attenuated anterior and blunt posterior extremities. Male minute, occurring in uterus and vagina of female.

Female (measurements of 18 specimens)

Length 6.5–15.7 (11.9) mm. Width at nerve ring 30–34 (32), at oesophago-intestinal junction 60–100 (84); maximum width 90–200 (150). Cuticle thin, with conspicuous, closely-spaced transverse striae anteriorly, less conspicuous in midbody, barely discernible posteriorly. Cephalic end narrow bearing single stylet, able to be retracted into minute buccal capsule. Oral opening dorso-ventrally elongate, with 6 minute lips each bearing single papilla. Amphids relatively large, papilliform. Oesophagus commencing as narrow muscular tube, broadening posterior to nerve ring, narrowing as it enters stichosome, passing laterally through stichocytes. Length of muscular oesophagus 120–200 (160); total length of oesophagus 1.38–2.41 (1.80) mm. Length of stichosome 1.20–2.21 (1.64) mm. Number of stichocytes 69–84 (74), anterior stichocytes regularly aligned in single column, posterior ones irregularly aligned in 1, 2 or 3 columns; cells approximately square, becoming more triangular in posterior half of stichosome, all with single large nucleus. Nerve ring 18–50 (26) from cephalic extremity. Oesophago-intestinal junction conspicuous, with two small mesenchymal cells, 1 dorsal, 1 ventral, each with single large nucleus. Vulva 1.40–2.45 (1.83) mm from anterior extremity, with small lip on each of anterior and posterior margins, with exceptionally thin cuticular lining. Vagina vera 132–167 (150), muscular, with exceptionally thin cuticular lining. Posterior intestine with narrow lumen and relatively thick muscular walls in immature females, with wide lumen and thin muscular walls in gravid females. Rectum with thick cuticular lining. Anus terminal, without lips or swelling. Tail blunt, often twisted or distorted in gravid females.

Lateral bacillary bands commencing in region of nerve ring as column 1–2 cells wide, broadening to 3–4 cells width at posterior end of stichosome, cells arranged irregularly. Bands becoming much wider just anterior to or level with vulva, extremely wide from here to posterior end and leaving only narrow dorsal and ventral columns of cuticle unornamented

except for diminishing transverse striae. In this region hypodermal gland cells projecting above level of body cuticle, papilliform, with single pore opening at apcx, most pronounced in posterior half of body in gravid females. Lateral alae not observed.

Eggs in distal uterus 70–80 (75) long, 34–76 (40) wide, variable in shape, thin in one profile thick in opposite, plugs not protruding, shell dark amber brown, smooth; eggs containing larvae; larvae hatching in distal uterus in some specimens.

Females containing 2–8 (5) males, usually in distal uterus or muscular vagina of non-gravid females, usually in posterior uterus of gravid females. One female with anterior half of male protruding from vulva.

Male (measurements of 10 specimens)

Length 1.25–1.65 (1.38) mm. Width at nerve ring 22–32 (28), broadening in posterior half; maximum width 40–70 (54). Cuticle with conspicuous transverse striae throughout. Cephalic end with two minute lateral papilliform structures, presumably amphids. Buccal capsule minute, 4–6 (5) long, stylet not observed. Oesophagus commencing as broad muscular tube, narrowing posteriorly as it enters stichosome, passing laterally through stichocytes. Length of muscular oesophagus 60–110 (87); total length of oesophagus 530–630 (582). Length of stichosome 440–530 (493). Stichocytes as described in female, cell walls often indistinct making counting difficult; approximate number stichocytes 65–74. Nerve ring 25–34 (28) from cephalic extremity. Oesophago-intestinal junction indistinct. Intestine broad, thick-walled. Intestine and vas deferens uniting to form short muscular cloaca, 70–80 (76), without cuticular lining anteriorly. Cloaca modified distally into short thick-walled cuticular duct without musculature, 30–37 (34). Spicule absent. Spicule sheath absent. Tail blunt, cloacal opening terminal.

Lateral bacillary bands similar to those in female, not as broad, with fewer gland cells. Bands commencing as column of single cells posterior to buccal capsule, broadening to column 2 cells wide posterior to nerve ring, continuing throughout body length as column 2–3 cells wide. Gland cells becoming papilliform near posterior end of stichosome, projecting above level of body cuticle, each with single pore opening at apex. Gland cell openings separated or grouped in lots of 2 or 3 by short conspicuous transverse striae.

Discussion

Members of the genus *Trichosomoides* are parasites of the mucosal surfaces of murid rodents. Only two species are known; *T. crassicauda*

(Bellingham, 1865) Railliet, 1895 from the urinary tract, generally the bladder, of wild and laboratory rodents throughout the world, and *T. nasalis* Biocca & Aurizi, 1961 from the nasal cavity of *R. norvegicus* in Rome. This species was recorded in the wild for only the second time by Cross *et al.* (1970) who reported a prevalence of 4.2% in *R. exulans* (Peale) in Central Java, Indonesia. Later, Cross & Santana (1975) reported *T. nasalis* in 24% of *R. coxingi* Swinhoe examined on Taiwan. Number of worms per infected host ranged from 1–15 with a mean number of 4.5 nematodes per animal. Bernard (1964) described *T. gerbillis* from the stomach of *Gerbillus pyramidum hirtipes* Lataste in Tunisia but this was later transferred to *Anatrichosoma* (Pence & Little, 1972). Males of the genus *Trichosomoides* are unique among parasitic nematodes for their habit of dwelling in the uterus and vagina of the female worm.

Morphological differences between *T. nasalis* from *R. norvegicus* in Rome and the specimens from *R. fuscipes* in southeastern Australia are slight. Biocca & Aurizi (1961) illustrated 59 stichocytes in the stichosome of the female. A variable number of stichocytes occur in male and female nematodes from *R. fuscipes* and I observed 70 stichocytes in a co-type female fragment (non-gravid) from *R. norvegicus*. Measurements of morphological features of both male and female *T. nasalis* from *R. norvegicus* reported by Biocca and Aurizi (1961) and observed by me are slightly greater than those of specimens from *R. fuscipes*. These differences are viewed as insignificant, possibly host-induced and certainly not warranting separate specific status for the material from *R. fuscipes* in Australia, which is here recognised as *T. nasalis*.

A characteristic feature of male and female *T. nasalis* is the form of the lateral bacillary bands, particularly in the posterior half of the body. In this region the hypodermal gland cells project above the body cuticle, are papilliform or dome-shaped and bear a single pore opening at their apex. This feature was observed by Biocca & Aurizi (1961)—“... papilla-like cuticular elevations nearly 10 μ m in diameter.”—and may be seen in their illustration of the female nematode. These authors' observation of the conspicuous nature of the elevations on the ventral surface of female worms is misleading. The bacillary bands originate on the lateral surfaces but become extremely wide posterior to the vulva, leaving only narrow dorsal and ventral columns of cuticle without gland cell pore openings, and thus unornamented, except for weak transverse striae. Spratt (1982) commented on the similarity in form of the hypodermal gland cells in species of *Trichosomoides* and three members of the genus *Anatrichosoma*.

The records of *T. nasalis* in *R. exulans* in Indonesia, *R. coxingi* on Taiwan and now in indigenous *R. fuscipes* in Australia add weight to the suggestion that this nematode species may be widely distributed throughout the world (Cross *et al.*, 1970; Cross & Santana, 1975).

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